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NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 2-90

ARTIC COLD WEATHER MEDICINE AND ACCIDENTAL HYPOTHERMIA

LCDR JOHN A. STERBA, MC, USNR

MARCH 1990

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Arctic ice camp diving operations require routine and emergency medical care to be provided by a U.S. Navy Corpsman trained as a Diving Medical Technician (DMT). Unfortunately, there are few publications on cold weather medicine and Arctic diving operations to assist the DMT corpsman. This report will discuss common medical illnesses and injuries that occur in the Artic. It is based on a review of medical and operational literature and a recent deployment to the Artic. To encourage the highest state of medical care, specific guidelines for diagnosis and treatment will be found in the three paperback medical manuals included as part of the medical kit, listed in this report. The recommended medical kit was designed, tested, and evaluated by the author during extended deployment during diving operation ICEX-89 in the Artic. Topics discussed in this report include: cold acclimatization, recommendations for staying warm, conducting sick call and common

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medical problems such as dehydration, skin conditions, upper respiratory conditions, cold injuries including nonfreezing cold injury and frostbite, eye conditions, infectious diseases, psychological stresses, and common accidents and injuries encountered in the Artic. Due to much controversy in the medical and lay literature, the field treatment of hypothermia is discussed separately, reviewing both medical research and current treatment guidelines.

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I. INTRODUCTION

The Naval Sea Systems Command (NAVSEA) has tasked the Navy Experimental Diving Unit (NEDU) via Task #89-33 to prepare a report discussing Arctic cold weather medicine for inclusion in the Arctic Operations Manual (NAVFAC P992). Remote ice camp operations require Underwater Construction Team (UCT) divers to rely on a Diving Medical Technician (DMT) for both routine and emergency medical care. This report describes common medical illnesses and injuries in the Arctic to assist the DMT and UCT personnel to help prevent as well as treat casualties that may occur during diving operations in the high Arctic. Information in this report is based in part on the limited amount of published medical and operational literature on Arctic and Antarctic diving operations (1-2). Much of this report is from summarizing the published literature on emergency medicine and environmental physiology. Also included is the experience of the author in wilderness medicine including being the Diving Medical Officer during diving operation ICEX-89 in the Arctic Sea with a UCT in 1989. This report has received considerable input and editing from U.S. Navy corpsmen stationed at Underwater Construction Teams One and Two, plus corpsmen at the Navy Experimental Diving Unit.

Appendix A lists the recommended medical supplies to support USN personnel remotely deployed in the Arctic based on the medical illnesses and injuries commonly seen in the Arctic. This medical kit supplements the primary and secondary chamber medical kits required by the U.S. Diving Manual (3). This medical kit was designed, tested and evaluated by the author during diving operation ICEX-89. The three paperback medical references listed in Appendix A are also included in the medical kit. By referring to these well accepted medical references, the highest level of medical care can be delivered by the DMT corpsman for medical conditions listed in this report and others encountered during Arctic deployment. The quality of medical care will also depend on the degree of training and experience for the corpsman, and if possible, consultation with a physician, e.g., by radio to the Thule Hospital via operations at Thule Air Base, Greenland.

A medical history and physical examination by a licensed physician, including psychological assessment for strenuous duty, plus a dental screening by a dentist, are mandatory for Artic deployment. If the physician or dentist determines that a physical or medical condition would present an unacceptable risk to that individual or possibly jeopardize the mission objectives, that individual should be disqualified.

II. METHODS

This report will review common medical problems that occur in the Arctic environment. Medical conditions are listed in layman terms with the medical name in parentheses for easier reference to medical manuals. The emphasis will be on prevention and safety to avoid injury or illness which could jeopardize the mission and incur the risk of a medical evacuation (MEDEVAC).

III. RESULTS AND DISCUSSION

A. ACCLIMATIZATION

Acclimatization is the body's physiological adjustment to a new environmental condition such as cold temperature. Acclimatization is a very individual response and varies from one to four weeks (4). At first, shivering is very pronounced, but soon the body compensates by a more efficient conservation of heat into the body core, less shivering and less heat lost. Rapid cold weather acclimatization depends on the degree of physical fitness, recent cold weather exposure and working hard outside (4). Staging at a cold weather location like Thule Air Base, Greenland but not getting outside for hikes or cross country skiing does not allow for any acclimatization prior to deployment to the ice pack. Going between warm buildings via warm vehicles instead of 15 minute walks also prevents cold acclimatization.

Working or continually moving about in the cold teaches one to use extreme cold weather clothing to stay comfortable without sweating. It is best to feel slightly cool and constantly be working or mildly exercising to keep hands and feet warm. As mentioned, this speeds up the acclimatization process and it also reduces the fear of cold exposure in people inexperienced with Arctic conditions. Upon deplaning at the ice camp site, the command organization must insure that all individuals are kept warm by sustained, productive work.

Chronic medical problems, older age, having a cold or being dehydrated are believed to reduce the rate of acclimatization. Unfortunately, one cannot determine how acclimatized their body is without careful laboratory testing. Also, there are no known medications which hasten the acclimatization process.

B. TIPS FOR STAYING WARM

The old Inuit saying, "you sweat, you die" is very true. With the intense physical activity required for setting up an ice camp, taking off clothing layers will prevent overheating and sweating. Wearing synthetic (polypropylene or polypro) long underwear, socks and glove liners will also wick perspiration away from the skin increasing comfort and thermal protection. On exceptionally cold days, two layers of the thin polypro underwear or one thin layer under expeditionary weight polypro works well. Cotton or cotton/wool long underwear is less expensive, but it stretches and does not wick perspiration very well causing discomfort.

Recent U.S. Navy research on thermal protection has disproved a myth about how well synthetic insulation thermally protects if it becomes wet. Thinsulate, which proved to be the most superior insulation, lost 88% of the insulation value when wet (5-6). With Thinsulate outperforming wool, wet wool offers little if any insulation to the individual. Also, mylar covered, space blanket material in either clothing or dry suit undergarments would not benefit the individual by conserving any radiant body heat (5-6). Summarizing, clothing must be absolutely dry to provide optimal insulation.

With the Extreme Cold Weather Clothing System (ECWCS), thick pile undergarment pants can be removed without taking off the windbreaker (Gortex) outer shell by unzipping the side zipper up to the top. The zipper will come apart and the pile pants can be pulled up and out. To prevent overheating,

partially unzip the Gortex jacket and pile top. With rapid overheating, take off the hood or hat. Stuffing the hat deep into a pocket should be mentioned with inexperienced personnel frequently misplacing their hats as well as gloves. Loss of one's hat working away from camp may lead to hypothermia in high winds or a storm. Having an extra full face, balaclava hat, is a necessity. When stopping to rest, the hat and hood should be put back on right away. Remember, the head is an area of rapid heat loss that cannot be sensed by the individual. Conserving heat, and therefore energy, must become second nature in the Arctic.

With heavy work, taking off heavy gloves and using wool liners will also prevent overheating and sweating. Caution should be taken if handling metal objects such as tent poles. Due to the immediate heat loss from the fingers into the super chilled metal, frostbite can occur in minutes in Arctic temperatures. Under no circumstances should bare hands touch metal in the extreme cold, else the skin will freeze to the metal. Wearing thin glove liners made of polypro can help prevent this disabling and embarrassing mistake. Warm water or urine has been used to remove frozen fingers from metal in the field. Taking a drink from a metal cup can also lead to lips freezing on the metal resulting in very painful tissue damage.

C. THE C.O.L.D.E.R. PRINCIPLE

The C.O.L.D.E.R. principle, originated by the School of Survival, Spokane, WA, should be reviewed daily. "C" is for clean. Clothing, such as the polypro underwear, socks and glove liners must be kept clean to provide optimal insulation. Field wash the polypro with a cold water soap (e.g. Woolite). An occasional rinse in vinegar to remove body odor can be used before the final fresh water rinse. Polypro, woolen garments and cotton briefs will quickly dry overnight if suspended in a netting (gear loft) at the top of the tent where it is very warm and at low humidity.

"O" is for overheating. As discussed, insulation is decreased by perspiration. Also, perspiration will cause dehydration reducing one's defense against the cold.

"L" is for layers. Layers of clothing trap more dead air space which is the insulation against loosing body heat. Layers can also be removed to help regulate body temperature to prevent overheating and sweating.

"D" is for dry. Hard work in the extreme cold leads to sweating. This requires a change of socks, sometimes three times a day, to prevent the feet from becoming frostbitten or developing skin conditions such as athlete's foot or cracked, dry skin. Working in the wind with wet gloves can lead to frostbitten fingers in minutes.

"E" is for evaluate and "R" is for repair. At night, check over all clothing for cleanliness, and any tears. Zippers may need a very light coating of paraffin wax to keep them working smoothly in the cold. Putting too much paraffin wax on a zipper, filling in between the teeth, will cause the zipper to break.

D. ARCTIC BOOTS: ANKLE INJURIES AND TRENCH FOOT

For cold dry conditions, the fabric Mukluk boots must be worn loosely around the feet to provide optimal insulation. Unfortunately, they are not designed to give any ankle support and ankle sprains and fractures do occur. Over tightening the Mukluk boots will lead to cold feet and does not improve ankle support. Windblown conditions and wearing goggles especially with the fur-lined hood restrict vision of the feet. Exercise caution walking around campsite especially during camp set-up and break-down where building materials, sleds and gear adrift can easily twist an ankle. During ICEX-89, two separate ankle injuries, one fractured and one severely sprained, were attributed to wearing mukluks. The victims were inexperienced in wearing Mukluks and were also very fatigued. Both required MEDEVAC off the ice pack. Ankle injuries in people experienced in wearing Mukluks are uncommon

Mukluk boots must have dry felt booties and thick removable soles to thermally protect the feet. With sock changes, the felt bootie may need to be changed if wet from perspiration. Allow the felt booties, soles and nylon sole pads to dry overnight in the gear loft where it is very warm. Do not use the felt booties as slippers in the accommodation shelter, else they will become wet and dirty, reducing insulation. Leaving the felt booties and soles in the Mukluks on the cold shelter floor overnight will cause the boots to freeze by morning, even if the shelter air is warm.

The plastic, vapor barrier boots, (mickey mouse or bunny boots) are not recommended for cold dry conditions. If conditions are cold and wet and these boots are worn, frequent sock changes and strict foot hygiene are needed to avoid a condition called immersion foot or trench foot. Continually wet, cold skin breaks down, with tissue damage and frequent infection. Treatment includes bed rest, elevation of the feet with drying, keeping the feet warm, treating infection and controlling pain. The feet take very long to heal, and there may be pain with reexposure to cold.

E. SICK CALL

Daily sick call must be scheduled in the Plan of the Day as required by OPNAVINST 3120.32. This will help prevent self-treatment and allow the corpsman to treat conditions early and continue to encourage prevention and safety. Daily sick call permits early intervention for not only medical conditions, but for stress related conditions common on Arctic expeditions.

F. MEDICAL CONDITIONS

The signs and symptoms for the more common medical conditions will be briefly reviewed to assist with diagnosis and treatment. The rare but potentially serious medical problems in the Arctic are also listed in this report. The three paperback references accompanying the medical kit listed in Appendix A will assist the corpsman in diagnosing and treating these medical conditions according to current medical standards of care.

G. DEHYDRATION

Conditions aggravated by dehydration include: headache, agitation, loss of hand-eye coordination working with tools, and reduced foot stability.

Disabling and embarrassing constipation caused by dehydration and a change in diet frequently occurs 2-3 days into an Arctic deployment. Dehydration also aggravates upper respiratory infections which are very common during Arctic deployment, such as the common cold, a chest cold (bronchitis) or severe sinus infection (sinusitis). References 7-9, included in the medical kit, will provide current medical care guidelines.

Avoid using salt tablets, which worsen dehydration. There is more than enough salt in the food, plus the kidneys control salt content of the body. Chewing tobacco should be limited since it causes excessive drying of the throat and adds to dehydration by spitting and limiting drinking. Alcohol and caffeine beverages (coffee, tea, hot chocolate) worsen dehydration from increasing urination and should be limited.

Adequate drinking must be implemented into the daily routine. With working outdoors, one is frequently dehydrated. The human body cannot sense the large amount of water lost from the lungs from working outside, breathing cold, dry air. The color of urine should not be relied upon, alone, to judge if one is either dehydrated or drinking enough fluid. Although it is true that the urine can become very yellow with dehydration, multi-vitamins high in vitamin B will color the urine yellow, even if one is well hydrated. Drinking coffee or diving also increases the urination of clear urine, even though the person may be low on fluids. Make available large insulated containers of either water, sugar/electrolyte drinks or fruit juices at the work site, command tent, dive station and in the accommodation shelters. Insulated coolers will prevent the drinks from freezing outside or becoming warm inside. A large pot for melting ice in the shelters will not only increase comfort by raising humidity, it provides hot water for hot drinks (e.g. soup, cider). Have plenty of disposable cups to prevent sharing of cups and spread of disease. When working outside, drinking should be strongly encouraged every hour and inside, every two hours. Following any dive, drinking should also be encouraged to replace fluid loss caused by diving in cold water increasing urination.

In the Arctic, the cold will increase the number of times one has to urinate, day, and night. To avoid getting dressed and going outside at night to urinate, a plastic container with a secure cover behind one's bunk can save time and sleep. This urinal should be part of one's personal gear.

H. HYGIENE

Without proper skin care and prevention, simple skin problems become disabling due to cracking, bleeding and infection. Common skin problems aggravated by the cold and low moisture in the Arctic include athlete's foot (Tinea pedis), jock itch (Tinea cruris), and dry and cracked skin on the hands, feet, face, elbows, and knees. Wool also worsens the drying of the hands and feet by removing protective skin oils. Other common skin problems are blisters on the feet, chapped lips, windburn on the cheeks, nose and forehead plus irritating rashes in the underarms, rectal and groin areas. The face can be very irritated from exhaled moisture freezing a full face hat (balaclava). Beards freezing from the exhaled breath, actually worsen face thermal protection leading to frostbite. Ice in the beard can cause hair to be pulled out with skin damage.

I. GENERAL SKIN CARE GUIDELINES

Use heavy-duty babywipes to clean the skin without excessive drying. Do not use alcohol prep pads which take away natural skin oils leading to drying and cracking. Nightly sponge baths, using soap and a cup or two of water should begin with the face, then arm pits and last, crotch and feet. Following a sponge-rinse, the skin must be dry before putting on any skin cream, antifungal cream or dressing with dry and preferably clean clothes. Shaving should be done at night allowing the skin to replace lost oils from shaving before the next day. For short deployments (two weeks), shaving is not needed unless heavy beard growth collects ice, as discussed above.

Showers may be available using clean, hot water from food tray warming. Showers are not only hygienic, they improve morale. Rationing water can be done by the traditional "Navy shower": wetting down, turning off the water, soaping up, then a quick rinse. If water is being strictly rationed and showering is not available, hair washing improves well-being along with being hygienic.

Daily use of skin creams and lotions on the face, hands, feet and any area of dry, non-infected skin is recommended. With athlete's foot (Tinea pedis) or jock itch (Tinea cruris), use appropriate powders (tolnaftate and undecylenic acid) or if more severe, antifungal creams (1% clotrimazole or nystatin). Avoid using baby powder that has corn starch which aggravates fungal rashes such as athlete's foot and jock itch. For skin rashes that are very irritated, red, encrusted or weeping, a secondary bacterial infection may be present. This requires daily care, supervised by the corpsman. Infections may need oral antibiotics, following guidelines in the medical manuals accompanying the medical kit in Appendix A.

J. UPPER RESPIRATORY CONDITIONS

1. Mucous Membrane Drying

Frequently, the first complaints will be excessive drying of the upper airway leading to irritation. Presenting symptoms could be a nose bleed (epistaxis), sore throat, excess mucous from the nose or a dry, unproductive cough. With the relative humidity of Arctic air very low, these conditions resolve with becoming adjusted to the cold. Breathing through the nose will help to humidify the dry, cold air. If needed, medicated or normal saline nose drops can be used for 3 days, maximum, else nasal congestion rebound can occur even with normal saline. Bacterial or viral infection should also be considered by the corpsman if personnel have fever, feel sick (malaise) and have worsening symptoms.

2. Common Cold, Chest Cold, Sore Throat, Sinus Conditions

Cold, dry air and living in close quarters are reported to increase susceptibility for common colds, chest colds (bronchitis) and infected sore throats (pharyngitis) affecting nearly a third of individuals during Arctic deployment. With appropriate supportive care, adequate rest, plus clinically ruling out more serious conditions (e.g. sinusitis, pneumonia) personnel can continue their duties unless restricted by the corpsman for certain duties

(e.g. diving). References 7-9, which are the medical manuals in the medical kit, will guide the corspman, accordingly.

3. External and Internal Ear Infections

To prevent an ear infection of the ear canal (otitis externa), use Otic Domeboro ear solution, prophylactically, after each dive for 5 minutes in each ear (3). A diver with otitis externa is restricted from diving until the infection is completely treated following references 7-9, using Otic Domeboro or Otic Neosporin suspension for more severe otitis externa. Internal ear infection, behind the ear drum (otits media) also restricts a diver from diving until fully treated using references 7-9.

K. COLD INJURIES

The three types of cold injuries are chilblain also known as nonfreezing cold injury (NCI), frostbite and hypothermia. The factors of wind, temperature, duration of exposure and moisture from nearby open water all influence the type and extent of cold injury. Due to much controversy on the field treatment for accidental hypothermia, hypothermia will be thoroughly reviewed at the end of this report.

1. Chilblain or Nonfreezing Cold Injury (NCI)

Prolonged and repeated exposure of bare skin to near freezing air temperatures can lead to nonfreezing tissue damage. This also occurs at an accelerated rate during cold water diving, with prolonged extremity hypothermia of the hands and feet accompanied by pain or numbness. The limits of diving thermal protection are becoming more dependent on avoiding extremity hypothermia due to intolerable hand and foot pain and the loss of hand dexterity. In near-freezing cold water (-2°C sea water, 2°C fresh water), the finger tip temperature may drop to the pain threshold in 30 minutes if the diver is not generating sufficient heat by swimming or vigorous underwater work (10). This occurs hours before the body core temperature (rectal) would fall to hypothermic levels. Going beyond finger pain, into numbness, increases the risk of inducing nonfreezing cold injury, NCI. The mechanism of NCI is unclear, but prolonged cold exposure and tight gloves restricting finger blood flow may cause tissue damage and permanently alter the normal response to tissue rewarming and subsequent cold exposure (10). Following nonfreezing cold exposure, the rewarming process is accompanied by swelling, redness, pain and itching, which is similar to rewarming frostbitten tissue. The treatment of prolonged cold exposure leading to numbness would be the same as for frostbite: immersion in 40-42°C (104-108°F) water for quick rewarming to limit tissue damage from the cold (10). Narcotic pain relief (analgesia) may be needed.

If NCI has occurred, the diver will experience intense cold and pain very quickly in the hands upon subsequent exposure to cold water. U.S. Navy divers with NCI have actually been restricted from diving due to this intense pain.

The duration of initial cold exposure that will develop NCI is not known. With slow cooling of the hands, the diver may never realize his hands have become numb. In fact, some divers have noted that their hands developed an unusual warm sensation subsequent to mild pain. Based only on anecdotal reports from military cold water diving units, we would estimate that 60

minutes of finger numbness would probably cause NCI in most divers. There appears to be great variability between divers in susceptibility to NCI. The prevention of this disabling problem is being investigated by scientists who are now monitoring finger and toe temperatures during experimental and open-ocean dives in extreme cold water (10). Safe exposure limits for cold water diving can then be determined for dives using factors including varying levels of underwater exercise, water temperature, diving suit garment, and body type.

2. Frostbite

This frequent problem affects the following most common areas: cheeks, nose, ears, chin, forehead, fingers, wrist and toes. Previously frostbitten tissue may increase susceptibility to further frostbite. Signs and symptoms of frostbite include: blanching of pink skin to a white or grey/yellow color and initial pain or tingling sensation replaced by numbness which may go unnoticed. Ears may not feel cold and hurt before becoming frostbitten. Using the buddy system to check one another for white areas about the face or asking how one's fingers or toes feel is recommended. The treatment of frostbite is rapid rewarming by immersion in 40-42°C (104-108°F) water for quick rewarming to limit tissue damage from the cold (10). Narcotic analgesia may be needed. Less effective rewarming methods in the field would include warm hands over frostbitten areas on the face, frostbitten hands underneath armpits, or frostbitten feet placed into the hands, armpits or groin of another warm person. Avoid rubbing or massaging frostbitten tissue which causes tissue damage and does not add heat or improve circulation. Reference 8 will assist in the rewarming phase and help to prevent or treat subsequent infection of frostbitten tissue.

Prevention from frostbite should include carrying a spare change of socks, gloves and an extra hat to replace wet clothing if away from the ice camp. Remember to brush off snow and ice from clothing before coming inside to warm up, else it will melt and reduce insulation. If the hands become painful or numb, swing one hand at a time around in a great circle very fast, 10-15 times. This will increase warm blood flow out to the fingertips, temporarily rewarming the fingers and hand. Severe frostbite can rapidly occur when working around or under helicopters due to the rotor wash or behind air craft with prop wash causing very high wind chill factors freezing exposed skin in seconds. The windchill chart in the U.S. Navy Diving Manual (3) should be used as a guide. Below -75°F windchill, outside activities should be restricted unless operationally mandated.

L. EYE CONDITIONS

1. Eye Irritation

The Arctic conditions of cold, dry air, elevated wind chill plus Arctic diesel and jet fuel exhaust are very irritating to the eyes. Moisturizing eye drops can be used temporarily. Special note should be made concerning exposure of the eye to volatile liquids (gasoline, Arctic diesel) which in the cold can cause immediate freezing of the eye. Treatment includes flushing the eye with warm water, until intravenous (I.V.) solution can be used to irrigate the eye for at least 30 minutes.

Carbon dioxide absorbents (Sodasorb) will cause serious injury to the eye, requiring immediate irrigation with warm water until I.V. solution is available, for a minimum of 30 minutes. Do not use any acidic solutions in the eye, such as vinegar or weak acidic eye drops. These chemicals are difficult to remove from the eye and can lead to destruction of the eye unless there is aggressive irrigation, using a large syringe with a plastic catheter. Guidelines for eye injuries are outlined in reference 8.

2. Eye Infection

Any symptom of eye pain, redness, swelling, pus, or excessive tearing should be evaluated by the corpsman for eye infection and treated according to references 7-9.

3. Snow blindness

The ultraviolet rays of the sun, even on a cloudy day, reflect off the snow and can burn the outer layer of the eye, the cornea. Symptoms may not appear for 2 to 12 hours after exposure. Common symptoms are a burning or gritty sensation, excessive tearing, and eye pain with exposure to light (photophobia). As outlined in reference 8, treatment is eye patching, or remaining in a darkened room with medication for pain.

M. STOMACH AND INTESTINAL SYMPTOMS AND DISORDERS

Common stomach and intestinal disorders would include nausea, vomiting, stomachache, heartburn, gas, constipation, diarrhea and stomach flu (gastroenteritis). These are well described in reference 8 and 9, which also review potential complications and standard treatments. The rare problems encountered in the Arctic are Salmonella, Typhoid fever, Paratyphoid fever, Shigella (Bacillary Dysenteries), and Botulism (Clostridium botulinum), which are also well described in references 8 and 9.

N. INFECTIOUS DISEASES

With the physical stress of Arctic deployment, fever blisters (Herpes simplex) and genital Herpes simplex recurrences are frequent. These conditions are treated according to references 8-9. Impure water sources can lead to a number of disorders including backpackers diarrhea (Giardia), yellow jaundice (Hepatitis A). Typhoid, and bloody diarrhea from animal waste contaminating drinking water.

Improper food preparation, handling and storage can also lead to stomach and intestinal disorders from bacterial contamination. These problems require a thorough history, physical exam and close reference to references 7-9 for appropriate care.

Sexually transmitted diseases (STD) must also be anticipated from pre-deployment exposure. The current edition of reference 7 will direct appropriate antibiotic therapy.

The disorders from animals affecting man (zoonosis) that require consultation with references 7-9 include the following: (a) pneumonia and skin rashes caused by Tularemia from handling Arctic hare and other rodents; (b)

muscle pain and neurological symptoms from Trichinosis due to eating meat infected by the worm Trichinella spiralis (Beluga whale, Arctic fox, red fox, wolf, wolverine, walrus, Kodiak, grizzly, black and polar bears, plus both wild dogs and domestic sled dogs); (c) serious vitamin A poisoning from eating polar bear liver, (d) rabies from nearly one third of Arctic foxes in the Thule, Greenland area, plus wolves and dogs; (e) tick-born diseases; and (f) tapeworm diseases from fish or Echinococcus from sled dogs and other mammals.

O. PSYCHOLOGICAL STRESSES

Maintaining morale under Arctic conditions of long working days, intense cold and confined living space without much time for recreation requires special considerations. These recommendations come from seasoned Arctic personnel, military and civilian, who have learned to adapt and enjoy the Arctic. By following their advice, newcomers can avoid becoming inflexible and frustrated which could affect the success of the mission.

There is little privacy in an ice camp. Being courteous is greatly appreciated. When entering someone else's accommodation shelter, knock first or if a tent, say "knock, knock" before entering. The bunk is the only private place one has. Ask permission to sit on someone's bunk, and certainly don't use their bunk as a foot rest or a convenient place to lay gear down. With tempers being short, apologize early rather than too late.

Logistics personnel and engineering/science personnel should be in separate shelters to allow work to continue after hours. Science and engineering people usually do not see how logistics personnel must continually struggle with the efficient running of the ice camp. To avoid rivalry or conflicts, everyone in the camp must be continually kept informed with regular meetings to let everyone feel a part of the whole operation.

The military chain of command must be followed during strenuous Arctic deployment. However, "heavy handed" leadership styles without understanding of the additional stresses of Arctic conditions has led to rapid loss of morale, open anger and even mutiny on Arctic expeditions. Commanders and supervisors must monitor complaints and suggestions and offer positive reinforcement frequently. Commanders must be quick to recognize symptoms and should trust the input from corpsmen on the presentations of high stress and low morale. A rigid and inflexible military command structure devoid of humor and troop interaction is destined to create hostility and dissension in an Arctic ice camp. If inexperienced in Arctic conditions, commanders and supervisors must seek knowledge from those more experienced and should be offered the opportunity to err in order to learn for themselves unless there is obvious safety concerns. Usually inexperience related problems are self-correcting after one week when daily operations become less stressful and there is more free time to relax and interact.

Open gripe sessions should be discouraged, however the day-to-day complaining will surface naturally and can be addressed by those in supervisory charge if warranted. Mutual respect and a strong trust in one another will be fostered if legitimate concerns are promptly and professionally resolved. A desirable working relationship will result in an ice camp when personnel

witness their commanders and supervisors taking a sincere interest in everyone's well-being in this harsh environment.

Poor food is well known to adversely affect morale. When working hard outside in the Arctic, everyone looks forward to the next meal when people can collectively relax, warm up and socialize. The additional expense and effort to deploy a good cook or excellent packaged meals has been a high priority and has proven successful on previous Arctic expeditions and military deployments.

Suggestions for morale boosters include having enough scheduled free time and water for washing one's hair, a sponge bath and if possible, a shower. Clean underwear and socks maintains morale and improves hygiene, requiring enough time and water to be allotted for laundering. Operational schedules should be flexible enough to allow all personnel extra free time when working steadily in the Arctic for more than a week despite daily delays and changing operational scenarios. A scheduled day to sleep-in late with a later breakfast or a half day of work should be considered on a weekly basis for all hands.

Psychologists have studied man's behavior while deployed in the polar regions, in an effort to understand some of the common stresses. For newcomers to the Arctic, fear of the unknown, isolation, lack of a normal day/night sunlight schedule and long working days create problems with insomnia, mental fatigue, agitation, and depressed mood. The qualities of a productive ice camp with high morale have been found to include: a busy work schedule, good food consistently prepared on-time, free-time in the evening for hygiene needs and relaxation, planned and executed group activities such as a half-way party, igloo building contest, or group photo.

P. COMMON ACCIDENTS AND INJURIES

Despite the best of training, accidents will occur and can be anticipated by medical personnel. Many accidents in the polar regions have been attributed to restricted vision from goggles, hood and lens fogging, reduced hearing from engine noise and hat and hood covering ears, and decreased hand dexterity from thick gloves and cold hands. Heavy clothing and poor ankle support from mukluk-type boots have lead to ankle sprains and fractures. Fatigue, dehydration and hypothermia have contributed to lack of coordination and impaired judgement resulting in accidents with snow machines (snowmobiles, all terrain vehicles (ATV)). Keep arms and legs close to the body when operating vehicles or riding on sleds to avoid injuries. Operate snow machines safely. Playing crack the whip with a towed sled has caused serious injuries to both sled passengers and bystanders having restricted vision and hearing. Surfing on towed sleds has caused serious head injuries. All personnel should be cautioned on avoiding horseplay or risky practical jokes due to even minor injuries jeopardizing mission objectives.

Carbon monoxide poisoning continues to be a life threatening problem in the Arctic. Sources of this colorless, odorless, tasteless gas are diesel burning shelter heaters that have not been adjusted during initial lighting, generators with leaking exhaust systems, idling vehicles upwind of shelters or working parties, and using camp stoves inside tents. With portable recompression chambers becoming available on dive station, any subjective or objective evidence of carbon monoxide poisoning warrants a hyperbaric oxygen (HBO) treatment following the U.S. Navy Treatment Table 6. If no chamber is

available, 100% oxygen should be administered, and arrangements for MEDEVAC should be made with consultation to the Navy Experimental Diving Unit, relayed by radio through nearby military or civilian facilities. Reference 8 details supportive care guidelines while MEDEVAC to a hyperbaric facility is being arranged. In severe cases of carbon monoxide poisoning that seem to resolve without hyperbaric treatment, late neurological deficits may occur that could have been prevented by HBO therapy.

Q. HYPOTHERMIA

With much controversy in the lay and medical literature on the field treatment of hypothermia, this topic has recently been extensively reviewed (10) and is summarized to benefit the corpsman. Clinical hypothermia is defined as a body core temperature, measured rectally, below 35°C (95°F) (10). Many authors have subdivided hypothermia into mild hypothermia (32-35°C), moderate hypothermia (28-32°C) and severe hypothermia (below 28°C). However, rectal core temperature is frequently not available in the field, although desired. Therefore, the levels of hypothermia are described in this review by clinical signs, symptoms and physical exam. This practical approach will help to direct which patients are only mildly hypothermic and may rewarm in the field, passively with appropriate support. Moderate and severe hypothermia require active rewarming by invasive methods, which should only be attempted in a hospital setting, thus requiring MEDEVAC.

The following predisposing factors are frequently observed during cold water diving operations, and may contribute to hypothermia (10).

1. Dehydration from repetitive diving, excessive alcohol and caffeine consumption leading to increased urination (diuresis), aversion to drinking from sea sickness (e.g. Bering Sea operations), inadequate fresh water during Arctic/Antarctic diving operations, elevated insensible water loss from the lungs during strenuous outdoor activity without regular replenishment of fluids with sugar/electrolyte rehydration drinks.

2. Inadequate rewarming during repetitive cold water diving operations.

3. Diving after tending for prolonged periods leading to hypothermia before diving.

4. Wet or moist dry suit undergarments due to inadequate drying from perspiration or dry suit leaks.

5. Profuse sweating during strenuous dives, reducing insulation value of the undergarment, and then remaining at rest for prolonged decompression stops.

6. Inadequate thermal insulation: wet suits instead of dry suit, lack of dry suit training or diving experience to dive leak-free, undergarment selection too thin, too compressible or of poor insulation when wet (10), inadequate thermal insulation of the head.

7. Neglecting to heat inspired HeO_2 below 100 m (328 ft) (10).

8. Poor physical conditioning, lack of cold acclimatization, poor physical health due to chronic disease or acute illness and alcohol consumption suppressing shivering.

It is exceptionally rare to have hypothermia worse than mild hypothermia during well supervised Arctic diving operations, unless there has been a drowning with prolonged recovery or unexpected surface exposure from an aircraft accident or becoming stranded away from camp. Hereafter, the hypothermic diver will be referred to as the patient, but the treatment guidelines apply to surface exposure situations as well. With rectal core temperature monitoring taking considerable effort, e.g. removing diving gear, a rapid initial assessment of hypothermic diver depends upon a close examination of mental status, peripheral pulse, and presence or absence of shivering. The shivering response is maximum around 35°C (95°F) rectal body core temperature (10), the upper limit of mild hypothermia. If there is an absence of shivering, the diver's overall condition will tell if he is sufficiently warm or dangerously dropping below 35°C. By closely observing the diver immediately following the dive and conducting a physical exam outlined below, a clinical determination of the degree of hypothermia can be made, even without a rectal temperature. These physical findings are based on direct observation of hypothermic patients with adequate core temperature monitoring (10). It is written in medical terms for the benefit of the corpsman.

1. <u>Vital Signs</u>

a. <u>Temperature, rectal</u>. Mild hypothermia (32-35°C), moderate hypothermia (28-32°C), severe hypothermia (below 28°C).

b. <u>Heart rate</u>. Mild hypothermia: mild bradycardia is common when there is no shivering, but also tachycardia during episodes of shivering and with hypotension. Moderate hypothermia: pulse very weak with bradycardia more severe, irregular heart rate common with increased atrial ectopy and ventricular escape. Severe hypothermia: profound bradycardia, atrial and ventricular ectopy is worse, or pulseless from ventricular fibrillation or asystole

c. <u>Blood pressure</u>. Mild hypothermia: blood pressure varies, may be hypertensive especially during intense shivering but frequently hypotensive. Attempt blood pressure monitoring in between episodes of shivering, else there will be a false elevation. Moderate and severe hypothermia: increasing bradycardia, severe ectopy, cardiac depression, and severe hypotension develop. Remember, with a detectable radial pulse, systolic blood pressure is at least above 80 mmHg; a femoral pulse, above 70 mmHg, and a carotid pulse, above 60 mmHg (10).

d. <u>Respiratory rate</u>. Mild hypothermia: usually elevated, and may be labored especially with intense shivering. Moderate to severe hypothermia: respiratory rate declines or is absent, can become very labored with thick airway secretions (bronchorrhea) and lastly, pulmonary edema.

2. <u>General Condition</u>

With mild hypothermia, there is a range of shivering from intense to a rapid, undetected decline of shivering accompanied by sometimes an altered

sense of body warmth. Victims succumbing to mild hypothermia have disrobed in the cold due to this altered sensation of warmth. Confusion, stumbling gait, intense fatigue or sleepiness are common. The speech can be slurred from a cold face and central nervous system impairment. In moderate and severe hypothermia, the patient is not shivering, and may appear to be dying or be dead.

3. Mental Status

In mild hypothermia, judgement is frequently impaired determined by proverb or reasoning testing. Orientation is usually well preserved to time, person, place and situation, but short-term memory is very reduced with a shortened attention span or difficulty remembering three items, 5 minutes later. Long-term memory is preserved, such as addresses or birthdates. The affect is very labile from one extreme to another with the patient appearing agitated to lethargic, along with having high anxiety or appearing depressed. With moderate and severe hypothermia, there is increasing obtundation and unresponsiveness to pain testing on a dry suited diver by pressing underneath the eyebrow (supraorbital ridge), since the fingers are usually too cold and numb to induce pain from pressing on finger nails.

4. Physical Findings

a. Skin. In mild hypothermia, skin color may be pale from vasoconstriction, but frequently the face and hands are cyanotic with venous congestion caused by dry suit hood squeeze and wrist cuff squeeze. Exposure to high wind chill and direct exposure to water temperatures below 10°C will induce peripheral vasodilation and skin erythema. In moderate to severe hypothermia, the skin becomes very pale and cyanotic, with capillary refill not being able to be determined.

b. Ears. With mild hypothermia pale, waxy color indicates intense vasoconstriction but also frostbite. Tympanic membrane can be very erythemic from cold exposure and may be misdiagnosed as barotrauma or mild middle ear squeeze (Teeds Class I) (10). There are no remarkable findings with more severe hypothermia, except cyanosis of the external ear.

c. Eyes. From mild to severe hypothermia, the eyes increase in lackluster appearance, begin to lose reactivity in moderate hypothermia and are fixed, at mid-point to full dilation in severe hypothermia.

d. Throat. Frothy sputum from cold induced bronchorrhea is not seen in mild hypothermia, but can be common in moderate and severe hypothermia. During deep diving using helium/oxygen (HeO_2) with unheated inspiratory gas, bronchorrhea can develop quickly and may severely obstruct the airway of an exercising diver with normal body core temperature or mild hypothermia (10). The pink froth of pulmonary edema is a very late sign, seen in severe hypothermia.

e. Chest/Lungs. In mild hypothermia, evaluate the lungs by ausculatation and percussion in between the severe episodes of shivering. The lungs should be clear. Rhonchi from upper airway obstruction from bronchorrhea

is progressively observed from moderate to severe hypothermia. Rales due to frank pulmonary edema is a late sign in severe hypothermia.

f. Heart/ECG. As discussed above with assessing pulse, mild hypothermia is accompanied by a deepening bradycardia, separated by a more rapid heart rate with intense shivering. In moderate to severe hypothermia, there is a progression of increased atrial to increased ventricular ectopy, ending with asystole directly, or via ventricular fibrillation. Ventricular fibrillation spontaneously occurs and is refractory to defibrillation below $28^{o}C$ (10). This defines the critical upper limit of severe hypothermia. For those trained to interpret the ECG, the Osborne or "J"-wave, which is a conspicuous upward deflection at the R wave to ST segment junction, is often seen in mild to severe hypothermia, and may persist after adequate rewarming (10). Although considered pathognomonic for hypothermia, its presence or absence should not direct therapy since its physiological significance is still unknown (10). Shivering artifact on the ECG must not be misinterpreted as ventricular fibrillation. With shivering in periodic episodes, continuous monitoring will allow reasonable ECG traces between bouts of shivering. We have had good success with using modified Lead II monitoring to reduce shivering artifact. Two leads are placed superiorly and inferiorly on the sternum to avoid chest muscle artifact from shivering and the third lead still be placed on the left mid-axillary line (10).

g. Musculo-skeletal/Neurological. Emphasizing again, shivering is maximum at a rectal core temperature of $35^{o}C$ ($95^{o}F$), the upper limit of mild hypothermia. In between bouts of intense shivering the muscle tone and reflexes will be elevated in mild hypothermia, but will quickly become depressed in moderate to severe hypothermia. From 35^{o} to $32^{o}C$, shivering begins to decrease in intensity and frequency which can be dangerously misinterpreted as the patient not being that cold.

h. Abdomen/Urogenital. With the intense shivering and increased muscle tone of mild hypothermia, it is very difficult to initiate the relaxation phase of urination and there may be very painful bladder distension. Following cold water diving with mild hypothermia, urine volumes can exceed 800 ml, so be prepared! Bladder catheterization to relieve this urine retention in mild hypothermia has never been reported. Urination can lead to fainting, called micturition syncope. With blood pressure being labile, have the hypothermia patient urinate as close to horizontal body position as possible. Following urination, anxiety and overall malaise from hypothermia is greatly reduced. This will greatly assist the health care provider to better evaluate the mental status and physical exam of the hypothermia victim.

5. Hypothermia Treatment Guidelines

Immersion hydrostatically increases the intrathoracic blood volume, which also improves cardiac output by as much as 60% (10). Since hypotension and arrhythmias may occur upon removing the victim from the water in the erect position, try to keep the patient horizontal. Maintain the patient in a horizontal position after removal from the water. Handle the hypothermic patient gently, to avoid stimulation of the circulation or heart, which may precipitate arrhythmias. Do not let someone who is suspected of being hypothermic, walk or exercise until they are fully evaluated. Exercise, especially after cold water immersion, is suspected to cause sudden death if

the victim is moderately hypothermic. This may be due to sudden hypotension or a drop in the core temperature after cooling, called afterdrop. Suspected hypothermic victims may need to be restricted to lying down due to the mental confusion and agitation that is commonly observed.

The primary survey should rely on the First Aid principle of A, B, C: Airway, Breathing and Circulation, but add D for degrees and disability. Consider both hypothermia for degrees and cervical spine injury for disability. Most authors agree that cardiopulmonary resuscitation (CPR) should not be withheld, due to a lack of evidence that CPR would provoke lethal arrhythmias (10). There is no evidence to recommend that the rate of CPR be reduced, either, to support a reduced metabolic rate. Remember that victims of moderate to severe hypothermia look dead. The rule, which may need to be enforced at the accident scene or in the field is "no one is dead, until they are warm and dead".

Wet insulation greatly increases heat loss. Remove all wet clothing, including wet suits and if the dry suit undergarment material is even moist. Replace with the driest of insulation. As discussed, it is untrue that wet wool or even synthetic material such as Thinsulate maintains most of the insulation if wet (10). Also, radiant barrier material, "space blankets", would not reflect any significant energy (10), and would only serve to act as a wind barrier. Large trash bags are inexpensive and can be easily modified with adding a hole for the head to help reduce convective and evaporative heat loss for the victim in the field. Wrap the patient in the thickest, dry insulation possible. Cover the patient's head with thick hats to prevent heat loss from the head. Place the patient in an Arctic-grade sleeping bag inside the Heat Pac Rescue Bag or use similar insulation of many blankets. The Heat Pac bag has a hood covering, side straps for use as a litter and pulling straps in the front making it an ideal rescue bag if used with additional insulation. The Heat Pac Rescue Bag should be packed and stored with an Arctic-grade sleeping bag. High quality down sleeping bags can be water proofed and vacuum packed as small as the volume of a large textbook. Using a vapor barrier, or frost liner inside the sleeping bag will prevent loss of insulation from insensible water loss freezing inside the sleeping bag, especially from respiratory insensible water loss. A ground pad, inflatable or foam-type, will prevent conductive heat loss into the ground.

Protect the patient from wind chill and build a fire if on land. The radiant barrier, space blanket can be used to not only act as a wind screen, it will reflect the high radiant energy from the fire back to the patient. Begin your physical exam as outlined above. If rectal core temperature monitoring is available, let it guide you, but rely on your clinical exam and constant vital sign monitoring to treat the patient.

For mild hypothermia, providing there are no underlying metabolic disorders or drug or alcohol ingestion which may limit the shivering response, spontaneous rewarming will safely occur if the patient is well insulated. The most common agreement for the treatment of moderate to severe hypothermia is for these patients to be highly insulated, remain in a cold or "metabolic icebox" condition, and should be actively rewarmed only in the well controlled conditions of a hospital familiar with invasive rewarming techniques, such as peritoneal lavage or dialysis, extracorporeal rewarming, intubated inhalation rewarming or open thoracotomy with lavage (10). Arrange for MEDEVAC under

these conditions. The physicians at Thule Air Base Hospital have been given lectures and protocols on active rewarming techniques in 1989. As surgeons, they are prepared to use the warm peritioneal lavage technique. Presently, there are no effective, active rewarming techniques that can be used in the field. As discussed below, inhalation of warm, moist air by facemask does not warm the heart or improve rewarming rates. Other techniques to attempt rewarming for moderate to severe hypothermia are reviewed below.

It has been documented that chemical heat packs can cause third degree burns, with temperatures up to 77°C (170°F) (10). If used, they must be wrapped in some material to prevent burning the patient. Hot showers may induce hypotension and syncope in hypothermic divers and therefore should be avoided. Hot showers, which are available on larger ships and on extended Arctic deployments, may feel like a great amount of heat. However, the hot water suppresses shivering (10) and may not effectively rewarm due to little heat transfer plus increased evaporative heat loss. Vigorous rubbing of the extremities does not help to improve heat generated by the body. This may precipitate muscles to cramp, and stimulate cold venous blood back to the already irritated myocardium.

Intravenous (I V.) fluids to combat the severe dehydration following cold water diving should be isotonic such as normal saline or lactated Ringers. Lactated Ringers should be avoided in severe hypothermia since the liver may not metabolize lactate well. The I.V. fluid should be prewarmed (pan of hot water or microwave, if available) up to 46°C (115°F) to prevent further cooling of the patient. If there is a protected gag reflex, warm sugar-containing fluids by mouth will not add that much warmth, but offer hydration, nutrition and pyschological relief to the patient with a protective gag reflex. Alcohol and caffeine containing beverages should be avoided due to the unwanted increase in urination. Warm electrolyte/sugar sports drinks are ideal in a field situation for oral hydration and moral support.

Bath rewarming in the field for moderate to severe hypothermia patients should be avoided. There should be no delays for the MEDEVAC of these patients to a hospital for complete medical monitoring during proven, invasive rewarming procedures outlined above.

Hot tubs are becoming common near cold water dive sites, and portable units are easily constructed at remote Arctic dive sites. A diver with mild hypothermia will not tolerate sudden immersion in water above 30°C (86°F), due to the altered sensation of scalding pain, especially hands and feet (10). If a small hot tub is available, use 30°C to begin rewarming and raise the temperature to 41°C (106°F) to safely accelerate rewarming.

With difficulty in medically monitoring the patient while immersed, bath rewarming should not be used for other than stable patients with mild hypothermia. Regarding the risk of having the extremities in hot water, a recent study did not find any difference between leaving arms and legs out or in the bath, to influence the continued drop in core temperature with rewarming, afterdrop, or the rewarming rate in subjects with mild hypothermia (10). Unfortunately, warm water immersion may induce arrhythmias from cold venous blood returning to the heart in patients colder than those used in this study. The benefit of warm water immersion to support circulation and increase

the r··arming rate must be weighed against the possibility of inducing arrhythmias.

Arrhythmia prophylaxis with lidocaine or bretylium is an area under investigation now. Although frequently used, the doses have not yet been recommended based on a lack of physiological studies of dose response with varying temperature of cooled myocardium. Until these studies are done, standard Advanced Cardiac Life Support (ACLS) doses are recommended. Caution should be applied with using any ACLS recommended drug with hypothermia reducing peripheral circulation. Rewarming can release high drug concentrations, leading to toxic reactions.

In the field, supportive care is directed to help the patient generate heat by shivering while providing hydration and nutrition, if tolerated, and also maximizing insulation and protection from the cold. Recent studies on eight diver-subjects at the Navy Experimental Diving Unit have demonstrated that the Heat Pac unit, which burns charcoal and blows warm air around the patient, did not provide sufficient heat to significantly improve core rewarming following hypothermia (10). The Heat Treat unit which provides warm, humidified air by facemask did not improve core rewarming in the same study, either (10).

There are serious safety hazards with both of these peripheral and inhalation rewarming techniques. The Heat Pac charcoal burner/blower unit exhaust tube easily disconnects and is only one foot long. This causes a lethal risk of carbon monoxide (CO) poisoning inside the sleeping bag or tent due to a measured 500-1000 ppm CO exhaust from the unit (10). If the battery is placed in backwards, the fan spins in reverse, which will put out the combustion reaction, unknowingly. Do not use Heat Pac.

The Heat Treat unit that boils water to both humidify and heat the inspired air had numerous problems. Besides propane canisters freezing below -20 to -30^{o}C (-4 to -22^{o}F) due to moisture in all propane canisters, butane canisters will never light if the outside temperature is below 4^{o}C (40^{o}F) due to a low vapor pressure. When lighting the propane unit, even in still air, there were frequent large ignitions which burned the hair off the operator's hand and arm. The propane unit also overheated and melted the plastic and nylon it was standing on and was too hot to handle or carry. The CO output from the Heat Treat units was not measured, but due to the high combustion rates, it may be dangerously high inside a tent without adequate ventilation. The consumption of fresh water is very high, approximately, 450 ml (15.2 fl.oz.) every hour. This puts great demand on having abundant, fresh water that must be very clean for this inhalation therapy. In the Arctic, fresh water is at a premium and always needed for hydration. The collection of water from condensation in the breathing tubes created a very uncomfortable breathing sensation (dyspnea) with high respiratory rates seen in mild hypothermia. The dyspnea with the Heat Treat was severe enough to nearly terminate the experiment in one hypothermic subject. The water going down the nose, in the mouth, into the eyes and saturating clothing around the face, head and neck was disliked by all eight diver-subjects. It was also very difficult at first to maintain constant inspiratory temperatures between 43-45^{o}C. If the temperature became uncomfortably hot, the subject could easily be burned in the face even if the breathing hose was immediately disconnected at the heater unit. The electrical

unit did not allow the temperature to be controlled any easier, using the same mixing valve of steam to fresh air. Do not use Heat Treat.

In summary, with a lack of significant physiological benefit, plus these safety hazards, these peripheral and inhalation rewarming techniques cannot be recommended for the field treatment of hypothermia. From these studies, the best recommendation would be for removing all wet clothing or dive suits, replace with dry clothing and maximize thermal insulation by using a thick sleeping bag surrounded by the Heat Pac Rescue Bag. As discussed, there are presently no effective methods to actively rewarm the hypothermic victim in the field. Active rewarming in the field by radio-frequency and extracorporeal rewarming techniques are still under investigation.

Of the few studies that tested body-to-body contact in one sleeping bag, there was no benefit to improve rewarming. With present sleeping bags designed to fit closely to one occupant, it is doubtful two people could be adequately insulated unless extra blankets, opened sleeping bags, and trying to reduce cold air pockets could be arranged. The option to zip two bags together requires special, compatible zippers. Under extreme conditions, as a last resort, body-to-body contact should be considered if insulation can be maximized.

For further information on extreme cold weather clothing, equipment and training, contact Exploration Products, Spokane, WA. Telephone: 1-(509)-927-8101, 1-(800)-448-7312. This organization has had numerous military contracts to outfit U.S. and Canadian Forces for Arctic deployment, including the UCT during ICEX-89 in the Arctic Sea.

6. Prevention of Hypothermia

Poor dive planning, obligating a cold diver to remain at rest during prolonged decompression, and repetitive dives with insufficient rewarming are usually the reasons for mild hypothermia during diving operations (10). Frequently, the coldest people conducting cold water diving operations are the tenders who must remain at rest, exposed to the cold while they support their divers. These tenders then rotate to become divers, but they are already cold, dehydrated and frequently long overdue for a meal. Dive supervisors must care for their tenders and insure adequate rewarming and rehydration before sending divers into the water. For reasons unclear, it seems to take over 24 hours to recover from even the mildest of hypothermia, after proper hydration, body core temperature and nutritional debts have been paid back. To reduce exposure to both topside support crew and divers, temporary dive shelters with portable heaters have been used with great success (10). Caution should be exercised with these heaters, since improperly adjusted, they put out dangerously high levels of carbon monoxide. This is not an uncommon emergency during cold water diving operations in the Northern latitudes (10).

The first level of shivering which can be suppressed, should warn the dive supervisor that the divers need to come out if they are not swimming or working hard to generate body heat. Uncontrollable shivering is a sign of inadequate thermal protection with hypothermia possibly developing and divers must be brought out of the water at once.

Despite the best of dive plans, there will be accidents with lost divers, injuries underwater or lost hot water supply to the divers hot water suit or gas supply. Divers also become very hypothermic following a dive with high wind chills and possibly sea spray with small boat operations causing substantial heat loss from evaporation.

IV. CONCLUSIONS AND RECOMMENDATIONS

This report provides a list of common illnesses and injuries in the Arctic with treatment guidelines summarized or referenced to the medical manuals that accompany the medical kit. The corpsman can deliver the highest level of medical care by relying on his training, experience, attention to detail, and consulting these medical manuals. Other personnel reading this report can help prevent these medical problems by improving safety. This report should encourage all personnel to seek the medical care and advice of the corpsman early, rather than late, to avoid a serious medical condition which could jeopardize the mission, or incur the risk and cost of MEDEVAC to a medical facility.

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APPENDIX A

MEDICAL KIT INVENTORY

Preface

This medical kit was designed, tested, and evaluated during ICEX-89 in the Arctic by LCDR J.A. Sterba during diving operations at a remote ice camp. This kit is to be used with the Primary and Secondary Emergency Medical Kits, listed in Chapter 8, U.S. Navy Diving Manual (3). The quantity listed for each item has been adjusted to support a 20-man ice camp and near by 60-man ice station, totalling 80 men for one month duration. Quantities will need to be readjusted, accordingly. Certain required items were not found in the NSN stock system and need to be open purchased or found at a U.S. Navy pharmacy. Transport of narcotics require proper U.S. Navy custody procedure by the corpsman or medical officer. Use of all medications require appropriate training.

Description of Items	Quantity
MEDICATIONS	
Morphine, injectable. 10 mg/2 ml	10
Demerol injectable, 50 mg/ml, 2 ml	10
Valium, inject, 10 mg/2 ml	10
Valium tabs, 5 mg	30
Tylenol #3 tabs	50
Tylox tabs (or Demerol tabs, 50 mg)	50
Narcan, injectable 0.4 mg/ml, amps	20
Nitroglycerine tabs, 0.4 mg, bottle	2
Nitroglycerine patch, 5 mg	30
Lomotil, 2.5 mg, tabs	50
Epinephrine, inject. 1:1,000, tubex	10
Diphenhydramine, inject. 50 mg, tubex	2
Albuterol inhaler	2
Aminophyllin tablets, 100 mg	100
Atropine inject., 0.1 mg/ml, 1 mg	2
Lidocaine inject., 20 mg/ml, 100 mg	4
Xylocaine 1%, 50 ml mult. dose vial	1
Xylocaine 0.5% with epinephrine 1:200,000. 50 ml mult. dose vial	1
Marcaine 0.5% with epinephrine 1:200,000. 50 ml mult. dose vial	1
Dextrose inject., 50%, Bristoject	1
Furosemide inject., 20 mg/2 ml, amp	6
Procainamide inject, 100 mg/ml, 10 ml	1
Bretylium tos. inject, 500 mg, 10 ml amp	2
Verapamil inject., 2.5 mg/ml, 5 mg	2
Hyperstat inject., 300 mg, 20 ml amp	1

Digoxin inject., 0.5 mg/2 ml, amp	6
Digoxin tabs, 0.25 mg, bottle	1
Dicloxacillin, 250 mg, caps	500
Ampicillin, 250 mg, caps	500
Septra DS tabs	100
Doxycycline tablets, 100 mg	100
Erythromycin, 250 mg, tabs	100
Cephalexin, 250 mg, caps	100
Cefadroxil, 500 mg	50
Ceftriaxone, 1 gm vial, powder	10
Diphenhydramine, 50 mg, caps	50
Proparacaine HCL, 5%, ophthalmic	2
Artificial tears, 15 ml	6
Eye drops, tetrohydrozoline, 0.05%	4
Sulfacetamide ophthalmic oint., 10%	2
Erythromycin ophthalmic oint.	2
Tobramycin, 0.3% ophthalmic soln	2
Bacitracin ophthalmic oint.	2
Atropine, 1% ophthalmic soln	1
Cyclopentolate, 1% ophthalmic soln	2
Meclizine, 25 mg, tabs	100
Diamox, 500 mg, tabs	50
Compazine, 5 mg, tabs	30
Compazine, 25mg, suppositories	24
Compazine injection, 50mg/2ml	10
Syrup of Ipecac, bottle	3
Hurricaine topical anesth, gel, dental	1
Triamcinolone acetonide dental paste	1
Tolnaftate 1%, powder	8
Clotrimazole 1%, cream	6
Hydrocortisons valerate, 0.2% cream	2
Zinc oxide ointment	2
Xylocaine, 2%, jelly	1
Nystatin/triamcinolone acetate cream	2
Hydrocortisone, 1% cream	2
Bacitracin ointment	10
Lindane, 1% cream	10
Ben Gay cream	3
Hemorrhoidal rectal suppositories	12
Motrin, 400 mg tabs	120
Naprosyn, 500 mg	50
Aspirin, buffered, tabs	500
Cimetidine, 200 mg, tablets	100
Antacid, tabs, Al/Mg	100
Antacid, liquid, 5 ft oz, bottle	6
Kaolin and Pectin mix, dehydrated	3
Peptobismol, tablets	100
Imodium, bottle	2
Dulcolax, 5 mg	100
Fleets enema	1
Rectal glycerin suppositories, bottle	1

Milk of Magnesia, bottle	1
Entex decongestant, caps	100
Tylenol, 325 mg, tab	200
Actifed tabs	100
Parafon forte	100
Sudafed decongestant, 30 mg tabs	300
Domeboro otic solution	1 per diver
Neomycin/Poly B/Hydrocortisone otic	4
Terpin hydrate elixir, bottle	5
Tessalon pearls, 100mg, bottle	1
Normal saline nasal spray, bottle	4
Afrin nasal spray, bottle	9
Cough syrup, expectorant, bottle	6
Cough syrup, expectorant/suppressant	6
Lanolin cream, tube	2
Throat lozenges, nonanesthetic	90
Throat lozenges, anesthetic	90

EQUIPMENT/BANDAGES/NEEDLES/SYRINGES

Dispenser, 1 fl oz	20
Dispenser, pill envelope	50
Applicator, cotton-tip	100
Tongue depressor, wooden	30
Bandaids	100
Alcohol prep pad	100
Betadine prep pad	100
Betadine cleanser, bottle	2
Finger cots, large, latex	20
Dressing, sterile, non-adherent	30
Gauze, rolled, Kling, 4"x 5 yds roll	8
Gauze, 4"x 4", sterile	50
Mole skin, 12"x 12" sheet	1
Tape, 1/2"x 10 yds, roll	8
Tape, 2", roll	5
Tape, 3", roll	5
Skin closure, 1/4" x 3", pack	10
Skin closure, 1/2" x 4", pack	6
Iodoform gauze, 1/4" x 5 yds, bottle	1
Aluminum acetate effervescense, tabs, 100	1
Silvadene cream, 400 gm, jar	1
Keri lotion, 2 fl oz, bottle	6
Dermatology recommended soap (Dial), bar	3
Nasogastric salem sump tube, 18 fr	1
Endotracheal tubes, 7.0mm, 7.5mm, 8.0mm	3
Laryngoscope with Miller and Macintosh blades	1
Oto-Ophthalmoscope	1
Stethoscope	1
Sphygmomanometer (BP cuff)	1
Heimlich chest drain valve	1
Gauze, vasoline, 3"x18", pack	1

Catheterization, urethral, sterile	1
Urinary drainage bag with Texas catheter	1
Red rubber urinary catheter, sterile	2
Penrose drain 7/8"	2
Penrose drain 3/8"	1
Surgical gloves, sizes 7 1/2, 8	2
Scalpel handles (2), assorted blades	1
Scalpel, disposable	3
Forceps, splinter, 3 1/2"	2
Scissors, Iris, straight	1
Needle driver, sterile	1
Forceps, Adson, sterile	1
Ear wax loop	1
Scissor, Metzenbaum, sterile	1
Scissor, bandage	1
Forcep, Kelly, straight, sterile	1
Reflex hammer	1
Whartenberg wheel, (pin wheel)	1
Surgical drapes, small	2
Surgical drapes, sterile, single use	1
Suture, 5-0 Dexon or Vicryl	3
Suture, 3-0 Dexon or Vicryl	5
Suture, 4-0 monofilament nylon	3
Suture, 5-0 monofilament nylon	4
Suture, 6-0 monofilament nylon	4
Suture 0 prolene, large needle	3
Bandage, elastic, Ace-type, 6"	1
Bandage, elastic, Ace-type, 3"	2
Bandage, elastic, Ace-type, 1 1/2"	2
Bandage, muslin, compressed	2
Dressing, first aid, field, 7 1/2"x8"	2
Fluor-i-strip, fluoescein paper	10
Fluor-dot cobalt blue penlight	1
Eye patches, gauze	10
Eyecup, plastic	3
Ammonia inhalant, caps	10
Syringe, luer lock, 50 ml	2
Syringe, cathetor tip, 50 ml	2
Syringe, 6ml with 22 ga needle	3
Syringe, 3 ml	6
Needle, 14 g 8"	5
Needle, 16 g 2"	5
Needle, 18 g 1 1/2"	5
Needle, 20 g 1 1/2"	5
Needle, 21 g 1 1/2"	5
Needle, 23 g 3/4"	5
Needle, 26 g 1/2"	10
Needle, 14 g 8"	5
Tourniquet, latex	1
Splint, pneumatic, leg	1
Splint, wire ladder, arm	1
Cervical collar, large	1

Cervical spine traction device (KED)	1
Splint, leg, traction (Hare)	1
Stretcher, (Reeve's Sleeve)	1
Hammock, nylon mesh	1
Bag mask resuscitator, in case	1
Oxygen, E or Super D cylinder, in case w/regulator (Life Support Products), valve wrench, nasal cannuals (2), masks (2), extension tubing to connect bag mask resus.	1
ECG/Defibrilator, Lifepack 5 with recompression chamber electrode cables, extra charged batteries, ECG, electrode paste, case.	1
Suction, foot-power (electric preferred)	1
Airways, nasopharyngeal, adult	2
Airways, oropharyngeal, adult	2
Thermometer, hypothermia, mercury (Zeal)	1
Thermometer, hypo/hyperthermia, electric (digital or analog) preferred with flexible rectal probes (3) (Yellow Springs Instruments) and lubricant	1
Thermometer, disposable (Temp-a-dot)	20
Batteries, D size	8
Batteries, AA size	14
Batteries, C size	8
Medical case, mount-out box	2

MEDICAL KIT BOOKS

Sanford JP. Guide to Antimicrobial Therapy, 1989 (published yearly), Antimicrobial Therapy, Inc., Box 34456, W. Bethesda, MD 20817-0456.

Tintinalli JE, Rothstein RJ, Krome RL (Eds). Emergency Medicine. A Comprehensive Study Guide. Second edition, 1988. McGraw Hill, New York, NY.

Orland MJ, Saltman, RJ (Eds). Manual of Medical Therapeutic, 25th Edition, 1986. Little, Brown and Co., Boston, MA.